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ABSTRACT

At the conclusion of their study on home pregnancy test kits, Valinas and Perlman (1982) suggested that the instructions accompanying the kits be revised to make them easier to read. A study was undertaken to determine the readability of the printed instructions accompanying five home pregnancy test kits (Daisy II, Answer, Acu-Test, Predictor, and e.p.t.) available in the United States and the degree of correlation of selected formulas (Flesch Reading Ease, Revised Dale-Chall, Fog Index, SMOG Grading, and Fry Graph) in measuring levels of reading difficulty for short, nontext publications. The mean reading grade level for Daisy II, Answer, and Acu-Test was found to be grade 7. For e.p.t. the mean reading grade level was grade 8 and for Predictor the mean reading grade level was grade 9. The correlations between sets of readability scores ranged from r=.40 to r=1.00, indicating a moderate to high degree of similarity in measuring level of reading difficulty for short, nontext publications. These findings suggest that all five instruction leaflets are readable for adults who have at least a seventh grade reading skill, but that the use of unfamiliar technical terms and certain polysyllabic words could reduce the clarity of the directions for some readers. (Author/NB)

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Title: Home Pregnancy Test Kits: How Readable Are the Instructions?

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Abstract: This study determined the readability of the instruction leaflets in five of the home pregnancy test kits available in the United States and the degree of correlation between sets of formulas. The mean reading grade level for Daisy II, Answer, and Acu-Test was grade 7. For e.p.t. the mean reading grade level was grade 8 and for Predictor the mean reading grade level was grade 9. The correlations between sets of readability scores ranged from r=.40 to r=1.00, indicating a moderate to high degree of similarity in measuring level of reading difficulty for short, nontext publications. All five instruction leaflets are readable for adults who have at least a seventh grade reading skill, but the use of unfamiliar technical terms and certain polysyllabic words may reduce the clarity of the directions for some readers.

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INTRODUCTION

At the conclusion of their study on home pregnancy test kits Valinas and Perlman (1) suggested that the instructions accompanying the kits be revised to make them easier to read. How easy or difficult are they in their present format? Are the instructions simple enough for a person with less than a high school level of reading skill?

A simple technique for predicting the reading grade level required in order to understand printed materials is a readability test. More than 40 different formulas (2) have been developed which measure the structural difficulty (e.g. vocabulary, sentence length, and number of syllables) of written publications. These counts of language variables provide an index of probable reading difficulty. Formula scores are derived statistically and, therefore, do not require actual reader participation. It is important to note that other factors related to readability, such as use of color and illustrations, conceptual difficulty, organization of material, or reader characteristics are not measured by readability formulas (3). They are only guides or general indicators of a possible range of difficulty of printed material.

This study was undertaken to determine the readability of the printed instructions accompanying five of the home pregnancy test kits available in the United States (4) and the degree of correlation of selected formulas in measuring levels of reading difficulty for short, nontext publications.

METHODOLOGY

The readability formulas

After reviewing the advantages, disadvantages, and predictive validity of the readability formulas developed since 1960 (2), the formulas chosen for this study were the Flesch Reading Ease, the Dale-Chall (Revised), the

Fog Index, SMOG Grading, and the Fry Graph. More than one formula was selected to examine the degree of intercorrelation between the formulas.

The Flesch Reading Ease formula has been one of the most widely used in the history of readability measurement (2). The formula is based on the number of syllables per 100 words and the average number of words per sentence. The formula is as follows:

R.E. = 206.835 - 0.846a - 1.015b

where a = number of syllables per 100 words

b = average number of words per sentence

Interpretation of the formula score according to reading grade level is made using a chart provided by Flesch (5).

Dale and Chall (6) presented their formula for adult materials in 1948. Klare (2) concludes that it is the most accurate readability formula, but it is difficult and time-consuming to apply. Like the Flesch formula, the Dale-Chall uses a variable of sentence length, but instead of using a syllable count for the second variable, a list of 3000 familiar words is used to determine the Dale score. The Dale score is a percentage of words outside the list (unfamiliar words). Determining which words are to be considered unfamiliar is the complicated and time-consuming aspect of the formula application. Powers, Sumner, and Kearl (7) provided a recalculated version:

Xc50 = 3.2672 + 0.1152a + 0.0596b

where: Xc50 = reading grade score of a pupil who could answer one-half the test questions on a passage correctly

a = Dale score

b = average number of words per sentence

The corrected grade-level corresponding to the raw score obtained from the

formula can be read from the correction table in Dale and Chall's original article (6).

Robert Gunning (8) developed a formula, the Fog Index, which is related to Flesch's Reading Ease Formula but simpler to apply. Rather than counting the total number of syllables in a passage as Flesch did, Gunning proposed counting words of three or more syllables. He called these "hard words," which were entered into the following formula:

Reading grade level (Fog Index) = .4(average sentence length + percentage of words of 3 or more syllables).

G. Harry McLaughlin (9) published a SMOG Grading system which he described as "laughably simple" but more valid than previous readability formulas. He retained the linguistic variables of word and sentence length but contended that they should be multiplied rather than added. By counting the number of polysyllabic words in approximately 30 sentences, he provided the following simple formula:

SMOG Grade = 3.0 + square root of polysyllabic count.

Since McLaughlin validated his formula against standardized reading passages at 100 percent comprehension rather than 50 percent, his formula gives scores approximately two grades higher than the Flesch, Dale-Chall, and Fog Index.

Edward Fry (10) developed a "Readability Graph" as a way of saving the user's time and effort. No formula as such was presented but the common language variables of syllables per 100 words and the number of sentences per 100 words are used. The user simply enters the counts of these two variables in a graph and reads the grade-level directly from it. The graph has been extended through the college years--level 17--and is the one used in this study (11).

Application

The instruction leaflets enclosed in the home pregnancy test kits vary in style and format but each one contains information about how the test works, performance of the test, how to read the test results, and what the test results mean. In addition, there is a description of the contents of the kit, whether a refill kit is available, and laboratory and/or user performance characteristics of the tests. Since the purpose of this study was to evaluate the reading difficulty of that portion of the instructions that might affect the effectiveness of the test, the sections on contents, refills and performance characteristics were omitted. In other words, only the sections that contained illustrated directions for performing the test were included.

A raw score and reading grade level were determined for each of the instruction leaflets according to the variables for each formula. The raw scores were then used to rank the five leaflets according to difficulty with number one the most difficult and number five the least difficult. The Spearman Rank-Order Correlation (12) was used to compute a correlation coefficient between sets of formulas.

Limitations of the study

Before inferences could be made from this study, the following factors had to be taken into consideration:

(1) The home pregnancy test kits chosen do not represent all such devices and were not randomly selected.

(2) Only five standard readability formulas were used from among the many that are available. All five formulas were manually applied to the printed instructional leaflets.

(3) Readability formulas provide an index of probable difficulty for

readers. They are predictive devices in the sense that no actual participation by readers is involved.

(4) These formulas do not take into account such important aspects of readability as organization, the nature of the content, or physical features of the material such as size of type and illustrations. They measure only language variables related to style as a determinant of reading difficulty.

RESULTS

Table 1 contains the reading grade level, formula raw score and rank order difficulty for each of the five instruction leaflets. The reading grade level varied by only one to two levels for a single leaflet in four of the five leaflets. The leaflet for the e.p.t. kit varied from a low of 7th grade as measured by the Flesch and Fry formulas to a high of 11th grade for the SMOG formula. SMOG scores tend to be two grade levels higher than those of the other formulas. In fact, the predictive validity of the SMOG depends on its disagreement with the other formulas (13). The additional increase of two grade levels can be explained by the larger number of words and sentences in the e.p.t. leaflet which in turn contains more polysyllabic words.

The mean grade level score from all five formulas for each separate leaflet is also presented in Table 1. Three of the five instruction leaflets average at the 7th grade level (Daisy II, Answer, and Acu-Test), one averages at the 8th grade level (e.p.t.), and one averages at the 9th grade level (Predictor). The mean reading grade levels are all at a junior high or low high school level.

A matrix of Spearman correlation coefficients computed by the SPSS program for nonparametric correlations (14) is presented in Table 2. The

highest correlations ($\geq .90$) exist between the Flesch and Dale-Chall, Flesch and Fry, and Dale-Chall and Fry. Previous attempts (2, 13, 15, 16) at determining correlations between these same sets of formulas as well as sets including the Fog Index and SMOG Grading have provided similar correlations. The low significance levels for the correlations in the range $r=.70-.72$ may be due to the small sample size in this study. It is not surprising that the relationship between sets of formulas among the five used in this study are so strong. The factors of writing style used in the formulas are similar and the original criteria for determining the level of comprehension are the same. The overall consistency of grade level scores and rankings produced in this study does indicate a moderate to high degree of correlation of the readability formulas to predict reading difficulty in short, nontext publications.

DISCUSSION

An advertisement for e.p.t. appearing in the March 1982 edition of Redbook (17) states:

> "You don't have to be a chemistry whiz or have any special skill to do the e.p.t. test--the directions are clear, and the test is simple (p. 24)."

The directions for e.p.t. and four other home pregnancy test kits are predictably easy for adults who have completed at least seven years of schooling. The percentage of adults who have completed seven grades of school is 87 percent, yet reading achievement levels have been dropping across the nation year after year after year (5). So even though the directions are easy, they may not be clear for some users of the kits.

Language variables that can be modified to improve clarity are the choice of more familiar and shorter words. Technical terms such as ampule, vial, tube, chemical pellets, and sedimentation which are familiar to a

laboratory technician may not be familiar to the average woman. However, if a woman using a home pregnancy kit has a good background in chemistry and a high knowledge of technical terms, the effect of improved readability may be diminished (18). Polysyllabic words such as "physician", "indication", "material", "illustration", and "incidence" could be replaced with shorter words such as "doctor", "sign", "supplies", "pictures", and "number". The argument has been made that making material more readable can or will "primerize" it and make it less acceptable. Klare (19) reviewed studies of acceptability and found this to be less of a problem than critics had supposed. Funkhouser and Maccoby (20) did, however, find a limit imposed by particular readers' intellectual level. They showed that while knowledgeable scientists found little difference in the comprehensibility of more or less readable versions of science articles written for the general public, they disliked the less readable version. Whereas these findings may affect a small percentage of women with a scientific background, they are not generally relevant to the revision of instruction leaflets used by the majority of female consumers in the United States.

Perhaps the next step in studying the readability of the instruction leaflets will be to determine the level of actual comprhension with a group of readers participating directly. Use of the cloze procedure (21) is one such possibility. Another question worth investigating is whether understanding the printed instructions has any effect on the accuracy of the test results? The findings from such a study might further clarify the reasons for the high rates of false-negatives and provide useful data to the manufacturers of home pregnancy test kits for reducing these rates.

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Table 1. Reading grade level, formula raw scores, and rank-order of difficulty

	Flesch		Dale-Chall		Fog Index		SMOG		Fry Graph		All Formulas	
Test Kit	Grade-level (Score)	Rank	Grade-level (Score)	Rank	Grade-level (Score)	Rank	Grade-level (Score)	Rank	Grade-level (Score)	Rank	Mean Grade-Level	Range
Daisy II	7 (70.84)	2	7 (6.28)	3	7 (7.90)	5	8 (8.83)*	3.5	7 (7.50)	3	7.2	1
Answer	7 (74.46)	4	7 (6.27)	4	9 (9.09)	3	8 (8.29)	5	7 (7.40)	4	7.6	2
Acu-Test	7 (74.56)	5	6 (5.89)	5	8 (8.40)	4	8 (8.83)*	3.5	7 (7.10)	5	7.2	2
Predictor	9 (63.87)	1	9 (7.15)	1	11 (11.58)	1	10 (10.68)	2	9 (9.10)	1	9.6	2
e.p.t.	7 (71.71)	3	8 (6.66)	2	10 (10.34)	2	11 (11.25)*	1	7 (7.60)	2	8.6	4

*more than 30 sentences

Table 2. Intercorrelations of five readability formulas

Readability Formula	Flesch	Dale-Chall	Fog Index	SMOG	Fry Graph
Flesch	----				
Dale-Chall	-0.900 (p=.019)	----			
Fog Index	-0.400 (p=.252)	0.700 (p=.094)	----		
SMOG	-0.462 (p=.217)	0.718 (p=.086)	0.564 (p=.161)	----	
Fry Graph	-0.900 (p=.019)	1.000 (p=.001)	0.700 (p=.094)	0.718 (p=.086)	---